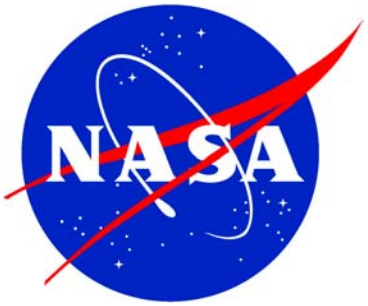
OMB Approval No. 2700-0087



Mission and Science Measurement Technology - 2004 (MSMT-2004)

NASA Research Announcement
Soliciting Basic Research Proposals

NRA 03-OAT-01
Issued: August 4, 2003

Notice of Intent to Propose Due:
August 18, 2003

Proposals Deadline:
October 3, 2003

Office of Aerospace Technology
National Aeronautics and Space Administration
Washington, DC 20546-0001

MISSION AND SCIENCE MEASUREMENT TECHNOLOGY - 2004 (MSMT-2004)

MISSION AND SCIENCE MEASUREMENT TECHNOLOGY

SUMMARY OF SOLICITATION

1.0 INTRODUCTION AND PROGRAM OBJECTIVES

The vision statement of the National Aeronautics and Space Administration (NASA) is

To improve life here,
To extend life to there,
and to find life beyond.

The mission statement of NASA is

To understand and protect our home planet,
To explore the Universe and search for life, and
To inspire the next generation of explorers
...as only NASA can.

To carry out this mission, NASA's Aerospace Technology Enterprise develops advanced technologies to enable revolutionary capabilities in aeronautics, space transportation, and scientific exploration. The Aerospace Technology Enterprise is managed by NASA's Office of Aerospace Technology (OAT), which sponsors a broad range of research programs organized under strategic themes.

One of the OAT themes is the Mission and Science Measurement Technology (MSM) Theme. The MSM Theme develops advanced system concepts, fundamental technologies, and engineering tools to enable future NASA missions and new science measurements. The primary customers of MSM Theme technologies are the other NASA Enterprises: the Space Science Enterprise, the Earth Science Enterprise, the Space Flight Enterprise, and the Biological and Physical Research Enterprise. The advanced system concepts and technologies developed by the MSM Theme are unique to NASA needs, and are applicable across many classes of missions in multiple NASA Enterprises. These products may require many years to progress from initial concept definition to mission infusion.

The objectives of the MSM Theme are to develop science-driven architectures and technology, to create knowledge from scientific data, and to develop capabilities for assessing and managing mission risk. Three programs have been formulated to accomplish MSM Theme objectives:

- *Computing, Information, and Communications Technology* (CICT) *Program* develops breakthrough information and communication systems to increase our understanding of scientific data and phenomena;
- *Engineering for Complex Systems* (ECS) *Program* develops the capabilities to assess and manage risk in the synthesis of complex systems;
- *Enabling Concepts and Technologies* (ECT) *Program* defines new system concepts and develops new technologies to enable new scientific measurements.

Further information about these programs, as well as access to the most recent Strategic Plans for both NASA and the OAT may be found through the OAT homepage on the World Wide Web at http://www.aero-space.nasa.gov/.

This NASA Research Announcement (NRA), entitled "Mission and Science Measurement Technology-2004," solicits proposals for exploratory research and technology development in the Enabling Concepts and Technologies Program (ECT) only. Future NRAs may solicit proposals in the Computing, Information, and Communications Technology (CICT) Program, or in the Engineering for Complex Systems (ECS) Program.

Proposals in response to this NRA should be submitted to the most relevant Program Elements given in Appendix A (see also the Table of Contents that prefaces this *Summary of Solicitation*). Table 1 at the end of this *Summary* lists these Program Elements in the order of their deadlines for the submission of proposals. Appendix A contains detailed descriptions of each Program Element, and questions about each may be directed to the Program Officer(s) identified in the "Programmatic Information" section that concludes each one.

Recommendations for funding for the proposals submitted to this NRA will be based on the peer evaluation of each proposal's intrinsic merit, its relevance to NASA's objectives, and its cost. For the purposes of this NRA: (i) by intrinsic merit is meant the proposal's science and technical merits, the capabilities of the proposing institution, the qualifications of the proposing personnel, and the overall standing of the proposal among similar proposals and/or evaluation against the state-of-the-art; (ii) by relevance to NASA's objectives is meant the proposal's relevance to the objectives as described in this NRA; and (iii) by cost is meant the reasonableness and realism of the proposal's requested budget, in addition to its size.

NASA's Vision and Mission given above now allow the second of these evaluation criteria, that of "relevance," to be clearly defined with respect to the overarching objectives of the Aerospace Technology Enterprise and this NRA. In particular, key Program Objectives and subsidiary Research Focus Areas (RFA's) for the MSM Theme are shown in Table 2 below (Note: these Program Objectives and RFA's are also used to assess NASA's research progress for compliance with the Gov*ernment Performance Review Act* (GPRA) of 1993). Therefore, proposers to this NRA are expected to provide a short statement in their proposals that shows how their proposed research activities support one or more of these Program Objectives and their related RFA's (note: further instructions of how this is to be done is provided in the first section of every Program Element given in Appendix A). The third element of the NASA Mission is directly addressed by the OAT Education and Public Outreach (E/PO) program that is discussed further in Section 4 below.

2. General Policies

2.1 Necessary and Sufficient Conditions for Selections

The Government's obligation to make awards through any program element announced through this NRA is contingent upon the availability of appropriated funds through the Federal budget

process from which payment can be made, and the receipt of proposals in response to this NRA that NASA determines through peer and programmatic reviews are acceptable for award.

2.2 Inclusiveness of Program Applicants

Participation in this program is open to all categories of U. S. and non-U. S. organizations, including educational institutions, industry, nonprofit institutions, as well as NASA Centers, and other U.S. Government agencies. Historically Black Colleges and Universities (HBCU's), other minority educational institutions, and small businesses and organizations owned and controlled by socially and economically disadvantaged individuals or women are particularly encouraged to apply. In accordance with NASA policy, non-U.S. organizations may participate only on a no-exchange-of-funds basis. For more information, refer to paragraph (L) of Appendix B of the NRA Guidebook for Proposers cited in Section 3.0 of this NRA.

2.3 Safety and Environmental Protection Policy

All prospective proposers to this NRA are advised that the highest priority in all of NASA's programs is given to safety and mission assurance, occupational health, environmental protection, information technology, export control, and security. NASA's safety priorities are to protect: (i) the public, (ii) astronauts and pilots, (iii) the NASA workforce (including employees working under NASA instruments), and (iv) high-value equipment, property, and information. All proposals submitted in response to this solicitation are expected to comply with this policy.

Similarly, NASA's vision and mission include "To improve life here,...To understand and protect our home planet...", which are consistent with the policy set forth in the National Environmental Policy Act of 1969 (NEPA). Approval of NASA research grants and contracts, and any subsequent use by or with NASA's approval of technologies, systems, processes, and products developed during research are potentially subject to environmental review under NEPA. NASA's environmental regulations setting forth its environmental policy and NEPA implementing procedures are found at 14 CFR part 1216. NASA encourages participants to consider in their research the development of technologies, systems, processes, and products that will both meet mission performance goals and be more environmentally benign or environmentally beneficial. Such technologies, systems, processes, and products will enable NASA to carry out its mission in an environmentally sound manner.

2.4 Export Control

U. S. proposals and proposals including foreign participation must include a section discussing compliance with U. S. export control laws and regulations, e. g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective proposer to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been

applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U. S. export regulations is available at http://www.pmdtc.org and http://www.bxa.doc.gov. Proposers are advised that under U. S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

Awards resulting from this NRA will contain the clause at NASA FAR Supplement 1852.235-73 with its Alternate II.

3.0 Instructions For Preparation and Submission of Proposals

All policies and procedures for the preparation and submission of proposals, as well as those for NASA's review and selection of proposals for funding, are now presented in a separate document entitled *Guidebook for Proposers Responding to NASA Research Announcements* (abbreviated as the *NASA Guidebook for Proposers*) that is accessible by opening the single Web site portal for the submission of proposals to any of the NASA program offices at the World Wide Web URL http://research.hq.nasa.gov/research.cfm, and linking through the menu item "Helpful References," or that may be directly accessed at URL http://www.hq.nasa.gov/office/procurement/nraguidebook/.

By reference, the newest edition of this *NASA Guidebook for Proposers, Edition: 2003 (January 2003)* is hereby incorporated into this NRA, and proposers to this NRA are responsible for understanding and complying with its procedures before preparing and submitting their proposals. Proposals that do not conform to its standards may be declared noncompliant and returned without review. Note that the required proposal *Budget Summary* is now combined with that for the *Cover Page/Proposal Summary* as one contiguous file. After the requested data are entered, the entirety of these contiguous forms are printed and signed by the designated personnel for submission with the required hard copies of the proposal.

The other chapters and appendices of this *NASA Guidebook for Proposers* provide supplemental information about the entire NRA process, including NASA policies for the solicitation of proposals, guidelines for writing complete and effective proposals, the NASA policies and procedures for the review and selection of proposals, as well as for issuing and managing the awards to the institutions that submitted selected proposals, and Frequently Asked Questions (FAQ's) about a variety of the NASA proposal and award processes and procedures. Comments and suggestions of any nature about this *Guidebook* are encouraged and welcomed and may be directed at any time to Ms. Rita Svarcas, Office of Procurement, Code H, NASA Headquarters, Washington, DC 20546-0001; E-mail: Rita.Svarcas-1@nasa.gov.

The World Wide Web site for submitting both a Notice of Intent (NOI) to propose (which is encouraged but not required) and a proposal's *Cover Page/Proposal Summary* and *Budget Summary* is given in Section 6, *Summary Information*, below (also Chapters 2 and 3 of the *Guidebook for Proposers* contain detailed information about these two subjects, respectively). A point of contact for assistance in accessing and/or using this Web site is given in the *Summary Information* below; nevertheless, interested applicants to this NRA are urged to access this site

well in advance of the various due dates for materials to familiarize themselves with its structure. It is especially important to note that every individual named on the proposal's *Cover Page* must be registered in the NASA data system that is accessible through this Web site and further, that such individuals must perform this registration themselves, i.e., a person may not be registered by a second party, even the Principal Investigator of the proposal in which that person is committed to participate.

4.0 OAT EDUCATION AND PUBLIC OUTREACH (E/PO) PROGRAM

As noted earlier, one of the three core missions of NASA is "…to inspire the next generation of Explorers as only NASA can." As part of its response to this mandate, the Office of Aerospace Technology is committed to fostering the broad involvement of the aerospace technology community in Education and Public Outreach (E/PO) with the goal of enhancing the Nation's formal education system and contributing to the broad public understanding of science, mathematics, and technology. Progress towards achieving this goal has become an important part of the broad justification for the public support of aerospace technology. OAT's work is also a significant element of the overall NASA education program. In response to education now being a core mission of NASA, an enhanced, coordinated Agency-level education program is now being undertaken through the new NASA Office of Education, which constitutes the Agency's sixth enterprise. NASA's education and public outreach objectives and focus areas are given in Table 3 below.

An overview of E/PO programs in the Office of Aerospace Technology may be accessed by opening the "Education" link on the OAT homepage at http://www.aero-space.nasa.gov. A summary of the key elements of the current OAT E/PO program that apply to this NRA are as follows:

- An E/PO proposal may be submitted only by a proposer (i) whose research proposal is selected for a funding award through this NRA or (ii) whose research proposal was selected through any previous OAT NRA and that has at least 15 months remaining in its period of performance at the time of submission of the E/PO proposal (in either case, hereafter called the "parent" award);
- The cost cap for an E/PO proposal by an individual investigator is $15K/year;
- An "Institutional Proposal" option is available that allows several OAT-funded researchers located at the same institution to collectively carry out a more ambitious, expansive E/PO program within a cost cap of $50K/year, not to exceed $125K over the nominal three year lifetimes of the parent awards;
- To ease the burden of NASA's administration of such small supplemental awards, the total period of performance for any E/PO award may not exceed that of its parent research award; and
- A selected Principal Investigator has two windows of opportunity to submit an E/PO proposal, either: (i) no later than 60 days after the date of his/her letter of selection for the new award (with the anticipation of starting the E/PO activity within the first half of the first year of the parent research award); or (ii) no later than 90 days in advance of the

yearly anniversary date of their award (with the anticipation of starting the E/PO activity in conjunction with the next year's funding supplement for the parent award).

For further details and specific guidance and information on preparing and submitting a proposal for E/PO funding under this NRA, contact the Aerospace Technology Education Program Manager, Mr. William Anderson, Office of Aerospace Technology, Code R, NASA Headquarters, Washington, DC 20546-0001; E-mail: william.e.anderson@nasa.gov.

5. ITEMS OF SPECIAL IMPORTANCE

5.1 ELECTRONIC SUBMISSION OF INFORMATION

OAT now requires the electronic submission of certain key elements of proposals through the World Wide Web (see below in Section 6, *Summary Information*). While every effort is made to ensure the reliability and accessibility of this Web site, and to maintain a Help Desk via E-mail and telephone, difficulty may arise at any point on the Internet, including the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with this site and to submit the required proposal materials well in advance of the deadline(s) of the Program Element(s) of interest.

5.2 ELECTRONIC NOTIFICATION OF OAT RESEARCH SOLICITATIONS

OAT maintains an electronic notification system to alert interested subscribers of the impending release of its research program announcements. Subscription to this service is free and is accomplished through the menu item "*To subscribe to the OAT electronic notification system*" found on the menu of the OAT research page at http://research.hq.nasa.gov/code_r/code_r.cfm. Due to the increasingly multidisciplinary nature of OAT programs, this electronic service will notify subscribers of (i) all NASA OAT research program announcements regardless of the type and science objectives, (ii) amendments to the solicitations that have been released for which the proposal due date is not past, and (iii) special news that OAT wishes to communicate rapidly to those interested in its programs. Altogether a subscriber may expect to receive 40 to 50 notifications per year. Note that OAT does not release this subscription list to any other user, nor does it attempt to discern the identity of the subscribers. Regardless of whether or not this service is subscribed to, all OAT research announcements may be accessed from the menu listing *Current (Open) Solicitations* at the Web site given above as soon as they are posted (typically by 8:30 AM Eastern Time on their date of release).

5.3 ARCHIVES OF PAST SELECTIONS

For more information about the types of research supported by the MSM Theme, titles for currently funded investigations selected under the Advanced Cross Enterprise Technology NRA (NRA-99-OSS-05) in 2000 are available at http://research.hq.nasa.gov/code_s/nra/current/NRA-99-OSS-05/winners.html

6.0 SUMMARY INFORMATION APPLICABLE TO THIS NRA

• Program Alpha-Numeric Identifier	NRA 03-OAT-01
• Date of NRA Issue	August 4, 2003
• Access to text	Link through the menu listings *Office of Aerospace Technology (Code R)* → *Current (Open) Solicitations* starting from the NASA Research Opportunities web site at http://research.hq.nasa.gov/research.cfm
• Requirements for preparation and submission of proposals (including default page limits)	"*NASA Guidebook for Proposers Responding to a NASA Research Announcement (NRA)-2003*" at URL http://www.hq.nasa.gov/office/procurement/nraguidebook/
• *Notice of Intent (NOI) to Propose* (encouraged but not required):	
- Desired Due Date	August 18, 2003
- Web Site for Electronic Submission	Open appropriate menu listing at http://proposals.hq.nasa.gov/proposal.cfm
- Late Submission (up to 15 days prior to Proposal Deadline)	(Help Desk by E-mail to proposals@hq.nasa.gov). Submit information specified in Section 3.1 of *NASA Guidebook for Proposers* by E-mail to proposals@hq.nasa.gov
• Cover Page/Proposal Summary and Budget Summary	
- Deadline	October 3, 2003; print completed items from Web site http://proposals.hq.nasa.gov/proposal.cfm
- Budget Summary	Units of dollars only (not K$).
- Web Site for Electronic Submission	Same as above (open for submissions starting ~ 45 days prior to Proposal Deadline (Help Desk by E-mail to proposals@hq.nasa.gov) Monday thru Friday 8:00 AM - 6:00 PM Eastern Time).
• Quad chart	
- Deadline	October 3, 2003; include printed copy in proposal using template from Appendix B, and submit electronic copy in Microsoft Powerpoint format
- Web Site for Electronic Submission	http://141.156.25.46/msmt/

• Proposal page limits	Unless otherwise specified in Program Element in Appendix A, default values are given in Section 2.3 of *NASA Guidebook for Proposers*.
Submission of Printed Proposal (including printed *Cover Page/Proposal Summary/Budget Summary*):	
- Required Number	Signed original proposal plus 15 copies.
- Deadline	4:30 p.m. Eastern Time, October 3, 2003
- Address for Submission by U.S. Postal Service, Commercial Delivery, or Private Courier	Mission and Science Measurement Technology Office of Aerospace Technology NASA Peer Review Services 500 E Street, SW, Suite 200 Washington, DC 20024 Telephone: 202/479-9030
• Selecting Official	Dennis Andrucyk, Director Mission and Science Measurement Theme Office of Aerospace Technology
• Announcement of Selections	Goal: 150 days after Proposal Deadline or 30 days after passage of NASA Fiscal Year 2004 budget, which ever occurs last.
• Initiation of Funding for New Awards	Goal: 60 days after Announcement of Selections
• Further information	See cognizant Program Officer(s) identified at end of each Program Element in Appendix A.

7.0 CONCLUDING STATEMENT

Your interest and cooperation in responding to this MSMT-2004 NRA for the Office of Aerospace Technology's supporting research programs are welcome. In addition, comments about the inclusive nature and/or structure of this NRA are also sincerely solicited and may be directed to either the Program Officers identified for each of the Program Elements in Appendix A or to the point of contact for "general NRA policies and procedures" identified in the *Summary Information* above.

J. Victor Lebacqz
Acting Associate Administrator
Office of Aerospace Technology

Dennis J. Andrucyk,
Theme Director, Mission and Science Measurement Technology
Office of Aerospace Technology

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TABLE 1

TECHNOLOGY PROGRAM ELEMENTS SOLICITED IN THE MSM-2004 NRA
(in order of the proposal due dates)

The MSM-2004 NRA solicits proposals for exploratory research and technology development in the Enabling Concepts and Technologies (ECT) Program only. Future NRAs may solicit proposals in the Computing, Information, and Communications Technology (CICT) Program, or in the Engineering for Complex Systems (ECS) Program.

NRA Appendix	Science Program Element (see Appendix A)	NOI Due Date [M/D/Y]	Proposal Due Date [M/D/Y]	Relevant OAT Programs		
				CICT	ECS	ECT
A.2	Advanced Measurement and Detection Technology	8/18/03	10/3/03			X
A.3	Large Aperture Technology	8/18/03	10/3/03			X
A.4	Low Power Microelectronics Technology	8/18/03	10/3/03			X

TABLE 2

OFFICE OF AEROSPACE TECHNOLOGY (OAT) STRATEGIC GOALS, THEME OBJECTIVES, AND RESEARCH FOCUS AREAS

Strategic Goal 10: Enable revolutionary capabilities through new technology.

OAT Program	Theme Objectives	Research Focus Areas (RFA's)
Computing, Information, and Communications Technology (CICT)	10.3 Develop breakthrough information and communication systems to increase our understanding of scientific data and phenomena.	(a) **IT Strategic Research** - Research, develop, and evaluate a broad portfolio of fundamental information and bio/nano technologies for computing. (b) **Computing, Networking, and Information Systems** - Provide seamless access to ground-, air- and space-based distributed computing, information, and knowledge to enable NASA missions. (c) **Space Communications** - Develop space communication technologies required to give NASA scientists pervasive, high data rate access to space assets and the data they acquire. (d) **Intelligent Systems** - Enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve the mission/science goals.
Engineering for Complex Systems (ECS)	10.1 Improve the capability to accurately assess and manage risk in the synthesis of complex systems.	(a) **Resilient Systems and Operations** - Enable mission systems that can analyze unexpected events and adjust plans and adapt systems accordingly with minimal human participation. (b) **System Reasoning and Risk Management** - System-wide life-cycle analysis and reasoning to identify and eliminate risks. (c) **Knowledge Engineering for Safe Systems** - Ensure knowledge is captured, integrated, and utilized continuously to improve safety. (d) **Advanced Engineering Environments** – A state-of-the-art engineering capability to dramatically improve business practices and the quality of services and products.

OAT Program	Theme Objectives	Research Focus Areas (RFA's)
Enabling Concepts and Technologies (ECT)	10.2 Create system concepts and demonstrate technologies that enable new scientific measurements.	(a) **Energetics** - Develop advanced power and propulsion technologies to enable lower-cost missions with increased capability, and to extend mission reach. (b) **Advanced Measurement and Detection** - Develop miniaturized, highly-integrated, and efficient instruments and sensors to provide increased scientific return. (c) **Revolutionary Spacecraft Systems** - Develop revolutionary spacecraft systems and architectures to enable distributed science data collection, explore extreme environments, and lower mission costs. (d) **Large Space Systems** - Develop concepts for large, ultra-lightweight space structures and apertures to expand mission capabilities, and enable new visions of the Earth and the Universe. (e) **Advanced Systems Concepts -** Conceptual studies and systems analysis of revolutionary aerospace system concepts that have the potential to enable new visions for NASA's strategic plans.

APPENDIX A

DESCRIPTION OF PROGRAM OPPORTUNITY

A.1 ENABLING CONCEPTS AND TECHNOLOGIES PROGRAM

1. Overview

The Enabling Concepts and Technologies (ECT) Program explores revolutionary concepts for aerospace systems, and performs fundamental research and development of high-payoff technologies to enable pursuit of the NASA Vision and Mission by all Themes and Enterprises. Program objectives are to identify, develop, and transfer breakthrough technologies that have broad potential across many types of systems to provide increased scientific return at lower cost, and to enable missions and capabilities beyond current horizons.

The ECT Program is the front end of the enabling technology pipeline that supplies the focused technology development programs of the NASA Enterprises. The revolutionary system concepts and technologies developed by ECT are unique to NASA needs, and are applicable across many classes of missions in multiple Enterprises. The ECT program involves three phases: Exploration, Transition, and Insertion. These phases are defined by Technology Readiness Levels (TRL), which are metrics used to assess the maturity of a particular technology product under development (For definitions of Technology Readiness Levels, see Appendix B of the NASA Technology Plan at http://technologyplan.nasa.gov).

In the Exploration Phase (TRL 1-3), promising ideas are developed without specific application. Technology requirements are derived from NASA strategic goals and objectives, advanced concept studies, and systems analysis. The technology requirements guide development of component and subsystem technologies, with emphasis on efficiency, miniaturization, integration, and resiliency. Broadly-competed solicitations and university partnerships are used to capture innovative ideas from the external community, to leverage emerging technologies, and to complement NASA capabilities in critical areas. This MSM-2004 NRA primarily addresses the Exploration Phase (unless otherwise noted in Appendix A).

In the Transition Phase (TRL 4-6), which is done in collaboration with the Enterprise customers, technology products are integrated into proof-of-concept systems to identify technical issues, to mature designs, and to validate performance in representative applications.

In the Insertion Phase (TRL 7-9), the performance of technologies is measured and evaluated in mission use to capture lessons learned that can benefit the next generation of technology development.

To ensure that new technologies developed by the ECT Program are picked up by users, a portion of program funding is allocated for the transition and insertion of products into Enterprise missions. This investment strategy bridges the gap between exploratory research and mission application. Customer investment (co-funding or partnership effort) is required for entering the

Transition Phase, and must constitute all costs in the Insertion Phase that are not related to performance prediction, measurement, and assessment.

Five projects have been formulated to accomplish ECT program objectives:

• The **Advanced Systems Concepts Project** performs conceptual studies and systems analysis of revolutionary aerospace systems that have the potential to leap well past current plans, or to enable new visions for NASA's strategic plans. Potentially enabling breakthrough technologies are examined in mission models, and the aggregated benefits of technology investments across multiple mission classes are evaluated.

• The **Energetics Project** develops advanced power and propulsion technologies to enable lower-cost missions with increased capabilities, and to extend mission reach beyond current horizons. Technology development includes solar power generation, energy storage and conversion, power management and distribution, and advanced electrical and chemical spacecraft propulsion.

• The **Advanced Measurement and Detection Project** develops miniaturized sensors, advanced instruments, and nanoscale devices to enable a wide array of in situ and remote sensing capabilities. Technology development includes lidar and radar instrument technology, detector arrays and cryocoolers for focal planes, broadband passive instruments, and in situ biological and chemical sensors.

• The **Revolutionary Spacecraft Systems Project** develops advanced spacecraft systems and architectures to enable distributed science data collection, exploration of extreme environments, and lower mission costs. Technology development includes formation control sensors and algorithms for distributed spacecraft, microspacecraft components and subsystems, and space environment models and analytical tools to predict environmental effects.

• The **Large Space Systems Project** develops concepts for large, ultra-lightweight space structures and apertures to expand mission capabilities, and to enable new visions of the Earth and the Universe. Technology development includes advanced materials, deployable and inflatable structures, multifunctional and adaptive structures, and ultra-lightweight optical systems.

This NRA solicits technologies in three major areas:

1. Advanced Measurement and Detection Technology
   - Development of detector arrays, laser sources, and in situ micro-instruments to support the Advanced Measurement and Detection (AMD) Project.

2. Large Aperture Technology
   - Development of technologies for large optical systems, antennas, and wavefront control to support the Large Space Systems (LSS) Project.

3. Low Power Microelectronics Technology
   - Development of low power radiation tolerant microelectronics to support the Revolutionary Spacecraft Systems (RSS) Project.

A. 2 ADVANCED MEASUREMENT AND DETECTION TECHNOLOGY

1. Scope of Program

The Advanced Measurement and Detection (AMD) Project is focused on developing new techniques and components that enable breakthrough capabilities for science and engineering payloads on NASA missions. These concepts and technologies are expected to both increase the range, quality, and quantity of information gathered while greatly decreasing the mission resources required to deploy advanced science payloads. To accomplish these goals, the AMD Project is investing in advanced micro- and nano- and quantum technological approaches to the sensing needs of the NASA Enterprises.

The AMD Project has three major targets of research and development to address critical needs for NASA:

1. Development of efficient and reliable laser sources, suitable for a range of active optical sensing (e.g. lidar) instrument concepts;
2. Creation and fabrication of detector arrays, active optical and electronic components, and sensing systems for wavelengths across the electromagnetic spectrum;
3. Integrated micro-instruments for in situ detection and analysis.

Proposals should outline a well-structured program (for up to three years) for development culminating in a proof-of-concept demonstration at Technology Readiness Level (TRL) 3-4 by the end of the effort. (For definitions of Technology Readiness Levels, see Appendix B of the NASA Technology Plan at http://technologyplan.nasa.gov)

To enable the NASA Office of Aerospace Technology to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must now demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (http://www.aero-space.nasa.gov/themes/strategic.pdf); see also the discussion in Section 1 of the Summary of Solicitation of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Theme Objectives, and RFA's given in Table 3 found in the Summary of Solicitation. In particular, this program element is designed to help fulfill the RFA for "Advanced Measurement and Detection." The appropriate place for this statementof relevancy is in the introduction to the proposal's "Scientific/Technical/-Management" section (see Section 2.3.5 in the Guidebook for Proposers). The index numbers in Table 3 may be used to identify the specific RFA, for example, "Goal 10, Mission and Science Measurement Technology Theme, RFA 10.2(b)."

The NASA Enterprises fund science payload technologies through unique competitive programs they have established (e.g. Code S - Research Opportunities in Space Science Astrobiology Science and Technology Instrument Development, Astronomy and Physics Research and Analysis, Planetary Instrument Definition and Development, Sun-Earth Connection Instrument Development; Code Y - Earth Science Technology Office, Advanced Component Technology

Program, Instrument Incubator Program; Code U - Advanced Human Support Technology Program). The AMD Project will work with the Enterprises to ensure that new technologies developed under this NRA are transitioned into these focused technology programs for further development. For technologies that are transitioned – either through agreement with the user Enterprise or through their selection into a focused technology program – the AMD Project will allocate funding to co-sponsor the development with the partner Enterprise.

1.1. Specific Areas and Technologies Solicited

1.1.1. Focal Plane Technologies for Remote Sensing, Active, and Astrophysics Instruments

Focal plane technologies are key to a wide range of remote sensing, active, and astrophysics observing missions within NASA; the capabilities and limitations of the focal plane sensor is often the driving design parameter for many space instruments. This solicitation is requesting new concepts and detector development that address the following key needs in NASA space-based photon detector systems:

- Focal plane sensors capable of photon counting detection in any region of the electromagnetic spectrum.
- Energy resolving focal planes in the X-ray to visible region, with an energy resolving power ($\Delta E / E$) of better than 50 in the visible
- Broadband (1.5 – 1000 micron), large format focal plane arrays capable of high operating temperatures (greater than 100K).
- Multicolor visible / infrared focal planes compatible with hyperspectral and ultraspectral imaging instruments.
- Large (megapixel) focal plane arrays with high quantum efficiency (greater than 50%) for imaging spectroscopy in the UV
- Detector arrays operating in the far infrared/submillimeter region (40 microns to 1mm). Array architectures, including both detector and readout, that are scalable to 1000's of pixels (e.g. 32x32 format) are desired, with detector NEP's lower than 10^{-17} W/$\sqrt{}$Hz. Concepts with polarization sensitivity incorporated into the pixel structure are especially sought in this call.
- Cryogenic multiplexer and readout electronics to interface with superconducting detector arrays such as transition edge sensor (TES) arrays and superconducting tunnel junction (STJ) detector arrays.
- Space qualifiable coolers and cryogenic support electronics to support detectors that operate at temperatures of 4 K or lower. milliwatt cooling capacities at 4K, down to 10 microwatts at 50 millikelvin.

1.1.2. Laser Materials and Systems for In Situ and Active Remote Sensing Applications

Laser spectroscopy is a fundamental technique for the detection and characterization of atmospheric constituents (e.g. water vapor, aerosols, trace gases), in the Earth's atmosphere, planetary atmospheres, and on crewed spacecraft. This solicitation is requesting proposals that will enable:

- Laser materials that can emit in the near- to mid-infrared (1 micron to 15 microns), the ultraviolet (200 nm to 400 nm), or far ultraviolet (~130 nm).
- Laser diodes with high electrical-to-optical efficiency for pumping of solid state lasers at 1 or 2 microns.
- Laser diode materials and structures that offer wider tunability than current state-of-the-art single mode diode lasers (> 0.1%).
- Efficient tunable laser transmitters that produce mid and long wave infrared (2.0 micron to 15 microns) or the ultraviolet (200 nm to 400 nm)

1.1.3. In Situ Sensor Systems for Astronaut Habitat Environmental Monitoring, Planetary Atmospheres, and Particle Measurement

Knowledge and control of the entire microbial and chemical environment is critical for astronaut health. Monitoring of the microbial environment includes the air, water, food, structures, and life support subsystems. Monitoring of the chemical environment includes detection of both organic and inorganic contaminants that could result from gradual buildup of, or accidental contamination with harmful chemicals.

In situ measurements are also necessary for a wide range of atmospheric, planetary, and space physics applications. Applications include the detection and characterization of organic materials on planetary surfaces, measurement of trace species in atmospheres, and the investigation of plasmas, particles, and fields in space.

This solicitation is requesting proposals for miniaturized in situ sensors and supporting components that address the technological issues associated with achieving the following characteristics:

- High sensitivity and accuracy of classification
- Decreased or no user interaction
- Decreased system mass, size, power, and other expendables
- Integrated ("lab in a teacup") biochemical analytical suites.
- A special area of emphasis is the development of sample acquisition and handling systems for monitoring of water quality. Advanced sample handling techniques that will enable the efficient, uncontaminated and repeatable acquisition of the sample and proper handling of the sample are solicited here, either as a stand alone capability or as part of a biochemical sensor system
- Another special area of emphasis includes the miniaturization of components for in situ sampling of gases, plasmas, particles, and fields.

The development of in situ sensors for monitoring the microbial and chemical environment supports the Advanced Environmental Monitoring and Control Program in the Office of Biological and Physical Research. Information on the content, priorities, and directions of the Advanced Environmental Monitoring and Control Program can be found at http://aemc.jpl.nasa.gov. Additional information is available at http://research.hq.nasa.gov/code u/code u.cfm. Click on "Program Plans, Requirements, and other Reference Documents."

2. Programmatic Considerations

2.1. Size and Duration of Awards

It is anticipated that $5.0M annually will be available to support AMD selections, pending the approval of the NASA's Fiscal Year 2004 budget. Awards are expected to range from $100K to $500K per year. Proposals may specify periods of performance of up to three years.

Progress reports for funding the second or subsequent years of research, for previously approved multiple year awards, will be considered separately and should be sent directly to the Advanced Measurement and Detection Project Manager 60 days before their funding anniversary date. In addition, the participation of all selected investigators in the annual AMD Project Review will be required.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Aerospace Technology (OAT) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening http://research.hq.nasa.gov/ and linking through "Helpful References," or by direct access at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2003-edition of the *Guidebook* is used for this solicitation). A table outlining a summary of instructions for the preparation and submission of proposals including reference points and page limits is provided in Appendix C.

- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal. Instructions for the electronic submission are provided in Appendix D.

- A quad chart in Microsoft PowerPoint format (template contained in Appendix B) will also be required. Include a printed copy in the proposal, and submit an electronic copy to http://141.156.25.46/msmt/

- Proposals involving NASA employees as either a PI or a Co-I must use Full Cost Accounting in the Budget Summary, including all Civil Service salaries with overhead.

Questions about this program element may be directed to the cognizant Program Officer:

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A.3 LARGE APERTURE TECHNOLOGY

1. Scope of Program

The Large Space Systems (LSS) Project is focused on developing technologies for large space apertures such as radiometers, radars, lidars, and telescopes. The overarching goal of this solicitation is to achieve breakthrough enhancements in mission capability and reductions in mission cost, primarily through advances in structures, materials, optics, and adaptive systems. Large Aperture technology will enable bold new missions of discovery for Earth and Space Science, and ultimately for all of NASA.

The focus of this solicitation is on new technology demonstrations of deployable lightweight apertures, and active and adaptive systems for correcting wavefront errors of telescopes and large antennas. In particular, there are three areas of emphasis:

1. *Large Optical Systems* - Large, lightweight scalable optical systems for imaging and monitoring celestial objects throughout the electromagnetic spectrum, but with an emphasis on visible through far-infrared. Also, moderate-sized optical systems for far-ultraviolet mirrors and lidar receiver applications.
2. *Large Radiometer and Radar Systems* - Large antennas for space-based radio astronomy and remote sensing of the Earth and other planets with radar and radiometers.
3. *Wavefront Control* - Active wavefront control to achieve and maintain the required surface precision/wavefront error of both telescope and antenna apertures in the presence of dynamic and quasi-static disturbances.

Proposals should outline a well-structured program (for up to three years) for development culminating in a proof-of-concept demonstration at Technology Readiness Level (TRL) 3-4 by the

end of the effort (For definitions of Technology Readiness Levels, see Appendix B of the NASA Technology Plan at http://technologyplan.nasa.gov). Proposals should define the system concept, describe its potential benefits for enhancing mission capability and reducing cost, identify enabling technologies, provide supporting analysis to substantiate system engineering tradeoffs, and fully describe modeling and validation approaches.

To enable the NASA Office of Aerospace Technology to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must now demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (http://www.aero-space.nasa.gov/themes/strategic.pdf); see also the discussion in Section 1 of the Summary of Solicitation of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Theme Objectives, and RFA's given in Table 2 found in the Summary of Solicitation. In particular, this program element is designed to help fulfill the RFA for "Large Space Systems." The appropriate place for this statement of relevancy is in the introduction to the proposal's "Scientific/Technical/Management" section (see Section 2.3.5 in the Guidebook for Proposers). The index numbers in Table 2 may be used to identify the specific RFA, for example, "Goal 10, Mission and Science Measurement Technology Theme, RFA 10.2(d)."

1.1. Background

NASA is studying future missions requiring large space systems for observation and remote sensing. Such large apertures are the basic energy-collecting infrastructure needed to measure the radiation and spectra from distant planets, stars, galaxies, and other cosmic objects, as well as those in our own Solar System. Key design parameters are the size, shape, figure, and temperature of the apertures. The aperture size determines resolution to which the image can be made, the area of the aperture determines how faint an object can be detected, and the figure determines how well the energy is concentrated on to the detectors. Cooling of large space telescope systems is needed to enable the next generation of high-resolution, high-sensitivity long-wavelength missions. Current methods of large aperture fabrication are not adequate to produce the required size and numbers of apertures at an affordable manufacturing and launch cost.

The specific type, composition, and properties of an aperture are highly dependent on the mission, and hence its intended application. Set against the benchmark of the largest ground-based telescopes and the 6-meter James Webb Space Telescope (JWST), future priority space science goals require a 10-fold increase in aperture area. The basic "building block" is likely to be diffraction limited optical collectors of 20-40 meter diameter each. One of the critical metrics for such systems is the areal density of the fully loaded primary mirror (defined as including the optical surface, reaction structure, actuators, and wiring). An areal density of 100 kg/m^2 is typical for conventional ground based telescopes, and JWST has a goal of between 10 and 15 kg/m^2. For future missions, areal densities of 1 kg/m^2 or less are required to enable affordable system architectures.

Large aperture technologies also have direct applicability to the needs of other NASA missions. For example, the Structure and Evolution of the Universe (SEU) theme needs large apertures for advanced X-ray telescopes, and for radio frequency, microwave, and sub-millimeter antennas. Space-based radio telescopes and Earth observing antennas for soil moisture and ocean salinity measurements will need great improvements in antenna technology in the near term. These new antennas will be characterized by sizes exceeding 25 meters in diameter, a fraction of a kilogram per square meter areal density, and operating frequencies between 0.1-183 GHz.

Several lidar instruments envisioned for future launch require meter-class (0.7 – 1.5 m) scanning telescopes to achieve desirable coverage and accurate measurements. Lightweight optics combined with novel telescope designs may allow scanning the laser beam on a space platform without substantial penalty of momentum compensation. Such telescopes must maintain a high degree of optical quality and pointing accuracy in the thermal and vibration environment of space.

1.2. Specific Areas and Technologies Solicited

1.2.1. Large Optical Systems

Example Science Needs:

NASA is studying future missions requiring large space observatories. The long-range goal of the Astronomical Search for Origins and Planetary Systems (ASO) theme in the Space Science Enterprise (SSE) is to detect and characterize planets in orbit around nearby stars. The Beyond Einstein Initiative of the Structure and Evolution of the Universe (SEU) theme, also in SSE, focuses on answering fundamental questions regarding the connections between space, time and matter. These grand challenges are a driver for large aperture technology development. In order to achieve the highest possible signal-to-noise ratio for missions operating at long wavelengths, the telescope optics and any support systems that fall into the beam pattern of an optical element must be cold to reduce the thermal emission which would otherwise dominate the detector signal. JWST will operate at < 50 K, but temperatures as low as 4 K are required for upcoming missions. Such missions include the Einstein Inflation Probe Observatory, which may require a large and cold submillimeter-wavelength telescope; the Single Aperture Far Infrared (SAFIR) observatory, which will have a 10 meter-class primary mirror for wavelengths in the IR/submillimeter; and the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS), which is a submillimeter interferometer. In addition to the systems for cooling large areas to 4 K, associated technologies are needed for the thermal control systems to provide the stability required for high sensitivity measurements.

One of the major goals of the SEU program is to probe the environment in the vicinity of black holes. Upcoming missions include the Micro-Arcsecond X-ray Imaging Mission (MAXIM), a 100-meter baseline interferometer utilizing grazing incidence diffraction limited optics, which will image a black hole. Large, lightweight X-ray mirrors are required for these efforts.

For missions beyond Terrestrial Planet Finder (TPF), including SAFIR and Life Finder missions among others, the ability to produce optics of sufficient size, mass, and precision is well beyond the state of the art. The Space Infrared Telescope Facility (SIRTF), which is cooled to less than

5.5 K, achieves this temperature by connecting the telescope and optical bench to a helium dewar. Using stored cryogen and connecting the telescope to a dewar will be nearly impossible for the much larger telescopes planned for the future. Thermal management techniques are undeveloped in this range.

NASA is also studying future missions for earth science observatories. These observatories will enable studies that include vegetation, ocean "color" - the study of dissolved organic matter and atmospheric aerosols. Wavelengths from the UV through the near infrared will be used. The study of these physical systems at the 20-500-meter spatial resolutions illustrates the need for large optical systems. Observations are planned from geosynchronous, near-geosynchronous orbits and Lagrange points. Large apertures are needed for 1 to 10 km spatial resolution from these orbits for full earth coverage.

Technology Required:

Table A.3.1 provides goals and figures of merit for various optical systems under consideration by NASA. Technology demonstrator proposals for these aperture types are solicited. Note that the far infrared / submillimeter optical systems require operating temperatures approaching 4 K. The areal densities include the reflector and all support structure and systems used to achieve the desired primary optical reflector. The parameters in this table serve to represent NASA's current understanding of high priority optics technology, but it is not intended to limit novel proposer concepts.

Table A.3.1: Goals for future NASA Optical Systems

	X-ray mirrors	**UV Mirrors**	**Visible**	**Scanning Lidar Telescope**	**NIR Earth Science Systems**	**Far infrared to submm**
Wavelength / Energy Range	0.05 -15 keV	100 – 400 nm	400 -700 nm	355 – 2050 nm	0.7 - 4 μm	20 – 800 μm
Size	1 - 4 m	1 - 2 m	6-10+ m	0.7 – 1.5 m	3m - 4 m	10-25 m
Areal Density	< 0.5 kg/m^2/ grazing incidence	< 10 kg/m^2	<5 kg/m^2	< 10 kg/m^2	< 5 kg/m^2	< 5 kg/m^2
Surface Figure	λ/150 at λ =633 nm	Diffraction Limited at λ =300 nm	λ /150 at λ =500 nm	λ/10 at λ = 633 nm	λ /75 at λ =1 μm	λ /14 at λ =20 μm

Proposals are solicited in the area of:

- Optical aperture technology systems scalable to the areal densities and sizes indicated in Table A.1. Proposals are to culminate in demonstration of proof-of-concept aperture at a size sufficient to show scaling to full-scale apertures, be approximately 1 meter in diameter or larger, and include proposer specified diffraction-limited performance and areal density.

- Deployment technology systems scalable to low areal density and large aperture. Proposals are to culminate in proof-of-concept aperture deployment demonstration at a size sufficient to show scaling to large apertures with specified areal density and alignment tolerances to within the capture range for wavefront control. Models that predict deployment and geometric distortions due to thermal, gravity, and other influences are to be included in the proposed effort.

- Since multiple launch packages may be necessary to form the complete telescope system, technology is solicited for modular optical systems and subsystems with connected modules. The modules may be either monolithic, deployed, or assembled on-orbit. (Note that distributed apertures that require formation flight and/or tethers are not the subject of this research announcement.)

- Large deployable, lightweight systems for distributed cooling in the range of 4 K applicable to an actively cooled radiatively coupled shield, as well as to direct cooling of infrared/sub-millimeter space telescope optics, including modeling tools. Proposals are to demonstrate proof-of-concept hardware, or a model validation experiment applicable or scalable to panel cooling to < 15 K with gradients < 3 K with specified size and areal density (which excludes remotely located cryocoolers) in a relevant thermal environment (regarding temperature and heat load).

Favorable technology system traits include:

- High packaging efficiency for small launch volume;
- Design traceable to space-durable materials;
- Robust system response to re-pointing of the aperture;
- High surface reflectivity after repeated deployment;
- Increase the collection area while maintaining or reducing costs and minimizing mass;
- Reduce the time required for precision mirror fabrication per unit area;
- The ability to perform metrology and test for such large aperture mirror technologies;
- Diffraction limited quality of mirrors.

Proposals that integrate two or more of the following are encouraged:

- scalable large apertures;
- metering structures;
- active/passive cryogenics (if applicable);
- deployment methods and mechanisms;
- modeling to show scalability of the proposed technology to larger apertures.

1.2.2. Large Radiometer and Radar Systems

Example Science Needs:

Many of NASA's Earth Science requirements over the next decade are science measurements that will be accomplished using observations at microwave frequencies, defined to be the range 0.1 - 183 GHz. These science requirements, defined by the Earth Science Enterprise as themes, require microwave measurements particularly in the areas of Solid Earth Science, Global Water and Energy Cycle, Oceans and Ice, and Atmospheric Chemistry and Solar Radiation. These themes tie the Earth's land, oceans, and atmosphere together into an integrated physical system. On land, soil moisture and snow are the key state variables of hydrology. Global soil moisture and snow measurements are critical to understanding and predicting changes in climate and in terrestrial ecosystems, to mitigating natural hazards such as floods and drought. In the oceans, information about sea surface salinity will improve climate predictions ocean rainfall estimates, and global hydrologic budgets. In the atmosphere, global prediction is the most important component driving the global water balance.

Observations within these themes at the spatial and temporal scales required in the post-2002 era face significant technological challenges. These measurements are based on relatively low frequency thermal microwave emission: 1.4 GHz for soil moisture and salinity, 10 GHz and higher for precipitation, 19 and 37 GHz for snow, and 60 and 183 GHz for atmospheric temperature and water vapor. The resolution of the measurements needs to be on the same scale as the physical process being observed. To resolve features at a fine scale, large apertures are required. The long wavelengths at these frequencies coupled with the high spatial and radiometric resolutions required by the various Earth Science Enterprise measurements necessitate the need for very large apertures (> 20 m) and highly integrated stable RF electronics on orbit.

Technology Required:

Table A.3.2 outlines NASA's goals for large-scale microwave antenna systems to meet its strategic Earth Science needs. These systems can be broken down into two types of microwave systems: Radiometers (passive remote sensing) and Radars (active remote sensing). Each system can be operated across various bands in the entire 0.5 GHz to 300 GHz microwave region. The areal densities include the distributed electronics and all support structure and systems used to achieve the desired antenna array/aperture. The parameters in this table serve to represent NASA's current understanding high priority antenna aperture technology, but it is not intended to limit novel proposer concepts.

Table A.3.2 Goals for NASA Radiometers and Radars

	Radiometers		RADARs		
	Filled Aperture Antenna	**Distributed/Synthetic Aperture Radiometer**	**Filled Aperture**	**Synthetic Aperture Radar (SAR)**	**Inter-ferometric SAR**
Wavelength Range	1.4 –300 GHz	1.4 GHz - 183 GHz	1.2 - 94 GHz	100 MHz – 18 GHz	1.2 - 18 Ghz
Array Size	25-50 m diameter	25-50 m x 25-50 m	Parabolic cylindrical Apertures 6-25m Planar >100m^2	Linear 50-100m x 3-5m	50-100 m x 3-5 m
Array/Aperture Areal Density	Mesh or membrane <2 kg/m^2	<2 kg/m^2	<3 kg/m^2	<3 kg/m^2	<3 kg/m^2
Boom Size		100 – 1000 times the wavelength		30-50m	10-50 m

Proposals are solicited in the areas of:

- Deployable antenna technology systems that demonstrate the technology needed for large space-borne radar and radiometer operating in the 0.5 to 300 GHz. Proposals are to culminate in demonstration of a scalable proof-of-concept antenna system of 1 meter or larger in size.

- Since multiple launch packages may be necessary to form the complete antenna system, technology is solicited for modular antenna systems and subsystems with connected modules. The modules may be either monolithic, deployed, or assembled on-orbit. (Note that distributed apertures that require formation flight and/or tethers are not the subject of this research announcement.)

- Integrated electromagnetic/structural designs are sought that maximize science performance with highly stable structural configurations.

Favorable technology system traits include:

- High packaging efficiency for small launch volume;
- Design traceable to space-durable materials;
- Robust system response to re-pointing of aperture;

- Deployment risk mitigation;
- Scanning of large apertures;
- Control and stability of rotating antennas in orbit;
- Widest possible wavelength range with one antenna;
- Minimum beam side lobes;
- Maintaining high beam efficiency with single and multiple beams;
- Wide field of view (meaning scanning range) with single antenna.

1.2.3. Wavefront Sensing and Control

Science Need:

For the planned large aperture missions, light-weighting of the apertures may reduce the performance of passive systems. It is expected that larger, lighter weight apertures will rely heavily on adaptive systems. Active and adaptive systems are needed for measuring and correcting surface figure and wavefront errors for large aperture telescopes and antennas and for controlling structural geometry and dynamics.

Technology Required:

Technology development is needed in the area of wavefront control technology for space based telescopes, interferometers, and their associated instruments. This technology encompasses all methods for creating a stable wavefront, and for maintaining the wavefront over operational environment, e.g. changes in time, temperature, gravity gradients, on-board vibrations, etc. Wavefront control encompasses all aspects of the observatory platform such as structural elements, optical assemblies, and optical elements such as mirrors and lenses. Major elements of a wavefront control system are: integrated systems model, wavefront sensing, on-board processor, wavefront control devices, internal metrology, and stability during operations, pointing, control algorithms and modeling.

There are a wide variety of wavefront control technologies, and the most suitable approach depends on trades between, for example, continuous and segmented, or single and dual curvature aperture architecture. Pointing and tracking, (including image stabilization over multiple exposures to increase signal-to-noise ratios), which fix the location of the science objects in the field of view, are as much a portion of wavefront control as are deformable mirror technologies that transform the wavefront into an optimal figure for observing. Modeling and control strategies and algorithms are also considered part of wavefront control. Hence the entirety of the technology is highly divided among sensors, physical devices, and their software interfaces, all of which influence the wavefront quality that affects the process of detection and measurement in a space observatory.

Proposals are solicited in the area of:

- Active and adaptive systems focused on high dynamic range correction applicable to large, lightweight deployable apertures of dual or single curvature, including control of primary or other optical elements at low-mid-and high spatial frequencies and either local

metrology or wavefront sensing to achieve diffraction-limited performance for wavelengths from the sub-millimeter through the visible. Proposals are to culminate in proof-of-concept demonstration of correction of errors of >10 λ to λ/15 at the focal plane with stability > 1hour in the presence of specified vibrations (e.g. those typical for nominal spacecraft operations hardware) on an aperture of sufficient size to be scalable to needed aperture size for specified wavelength (e.g. to > 8 m in IR, > 4 m in visible). Both open loop (active) and closed-loop (adaptive) will be considered, as well as computational architectures for meeting processing requirements on-board the spacecraft

- Active and adaptive systems focused on high dynamic range correction of radar apertures to λ/20 from errors of 100 λ, including alignment of the ground plane and the array plane to λ/2 with errors < λ/20. Antenna beam gain, shape (side lobe levels) and surface shape are key parameters effecting radar performance. The antenna beam efficiency greatly influences radiometer performance. Proposals are to clearly show the key active control design drivers and requirements for the proposed application.

- Reaction/support structure with integral actuation and metrology to provide the dynamic and quasi-static geometry control necessary for the precision wavefront control to be within the capture range.

Favorable technology system traits for large aperture wavefront control and alignment and phasing of segments include:

- Integral actuation with extreme precision (< 100 nm) and high range (> 1 cm);
- Integrally designed electromagnetic/structural compensation systems;
- Low thermal load actuation of optical systems;
- Low reaction force actuation;
- Integrated metrology (sensors) and actuation.

2. Programmatic Considerations

2.1 Size and Duration of Awards

It is anticipated that $5.0M annually will be available to support large aperture proposal selections, pending the approval of the NASA's Fiscal Year 2004 budget. Awards are expected to range from $300K to $500K per year. Proposals may specify periods of performance of up to three years.

Proposals may address multiple subtopic areas, however awards will remain in the $300K to $500K per year range. If proposals address multiple subtopics, the proposal should identify the principal subtopic for reviewer assignment.

Progress reports for funding the second or subsequent years of research, for previously approved multiple year awards, will be considered separately and should be sent directly to the Large Space Systems (LSS) Project Manager 60 days before their funding anniversary date. In

addition, the participation of all selected investigators in the annual LSS Project Review will be required.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Aerospace Technology (OAT) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening http://research.hq.nasa.gov/ and linking through "Helpful References," or by direct access at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2003-edition of the *Guidebook* is used for this solicitation). A table outlining a summary of instructions for the preparation and submission of proposals including reference points and page limits is provided in Appendix C.

- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal. Instructions for the electronic submission are provided in Appendix D.

- A quad chart in Microsoft PowerPoint format (template contained in Appendix B) will also be required. Include a printed copy in the proposal, and submit an electronic copy to http://141.156.25.46/msmt/

- Proposals involving NASA employees as either a PI or a Co-I must use Full Cost Accounting in the Budget Summary, including all Civil Service salaries with overhead.

Questions about this program element may be directed to the cognizant Program Officer:

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A.4 LOW-POWER MICROELECTRONICS TECHNOLOGY

1. Scope of Program

This solicitation requests proposals to develop radiation-tolerant low-power microelectronic (LP□E) components, design capabilities, and concepts that will enable and enhance ambitious Earth and Space Science investigations planned for late this decade and beyond. Selected activities are expected to advance the technology of spacecraft and instrument systems to the point where challenging science goals are achievable, and are consistent with tightly constrained cost resources.

This solicitation seeks to maximize the impact of the targeted technologies on NASA's Enterprises and to reduce the cost of systems development. Proposed components and concepts must demonstrate architectures, interfaces and approaches consistent with existing high-performance standards that facilitate this goal. User-configurable solutions that enable device interoperability are sought.

This research announcement seeks enabling and enhancing technologies that have potential for infusion into future spaceflight missions; selected deliverables may ultimately be used by aerospace systems developers to enable and enhance ambitions investigations. While the scope of this solicitation does not require responders to infuse their concepts into the aerospace development sector, efforts should be directed by this mid- and long-term objective; proposers must describe the feasibility of mapping their technology to this sector. Collaborative solutions involving educational and nonprofit institutions, industry and U. S. Government agencies are encouraged.

Proposed activities can have an entry Technology Readiness Level (TRL) of 1 or higher (For definitions of Technology Readiness Levels, see Appendix B of the NASA Technology Plan at http://technologyplan.nasa.gov). Proposers must identify the entry TRL, the planned exit TRL, and success criteria in their proposal. Past and ongoing work on the research activity should determine the entry TRL; proposers must substantiate the entry TRL in the proposal. The activity must demonstrate a minimum TRL 3, and advance the TRL by at least one level at the end of the proposed activity.

To enable the NASA Office of Aerospace Technology to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must now demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (http://www.aero-space.nasa.gov/themes/strategic.pdf); see also the discussion in Section 1 of the Summary of Solicitation of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Theme Objectives, and RFA's given in Table 2 found in the Summary of Solicitation. In particular, this program element is designed to help fulfill the RFA for "Revolutionary Spacecraft Systems." The appropriate place for this statement of relevancy is in the introduction to the proposal's "Scientific/Technical/Management" section (see Section 2.3.5 in the Guidebook for Proposers). The index numbers in Table 3 may be used to

identify the specific RFA, for example, "Goal 10, Mission and Science Measurement Technology Theme, RFA 10.2(c)."

1.1. Background

Many of the mid-term and long-term Earth and Space Science flight investigations require significant onboard signal processing to achieve their highly ambitious science goals. The power efficiency of existing spaceflight systems, however, limits processing capability, thereby imposing considerable performance constraints. This solicitation addresses this challenge by strategically investing in the development of low-power, radiation-tolerant technologies that will enable next-generation missions.

Low-power radiation-tolerant microelectronics is a transformational technology that could increase the computational capability of flight systems without a requisite increase in onboard resources. It also permits systems to process data at throughput levels achievable with existing technology, but with significantly less power. This technology advancement can significantly increase the capabilities of diverse mission scenarios:

- High-performance processors operating in severely resource-constrained environments will enable time-critical, numerically intensive science algorithms, application-specific lossy data compression and autonomous control strategies not tractable with the current generation of spaceflight processors.
- Planetary rovers will perform sophisticated navigation, control and science algorithms using highly capable low-power distributed processors.
- Cost-effective distributed spacecraft with low-power avionics and instrument components will enable measurements that span entire regions of interest (e.g., the Earth's magnetotail).
- Detectors with pixel counts orders of magnitude beyond those currently deployed will be tightly integrated with sensitive, low-noise, mixed-signal electronics that process wide-bandwidth sensor outputs with minimal thermal loading on the detector elements.
- Aerobots will autonomously navigate over distant planets and conduct sophisticated observational programs.
- Probes deployed to regions beyond our solar system will autonomously configure their systems to react to science of opportunity, and to mitigate effects of system degradation.

Although these scenarios differ, each science goal can be realized more effectively and efficiently with systems implemented with high-performance, power-efficient microelectronics.

1.2. Specific Technology Areas Solicited

This solicitation targets concepts, capabilities, and components in technology areas that significantly advance the power efficiency of spaceflight systems and can be affordably deployed across multiple missions. Proposed activities that address the following areas will be considered for funding through this solicitation (in no particular priority order):

1.2.1 High-Performance General Purpose 32-Bit and 64-Bit Microprocessors

This area solicits embedded processors capable of implementing computationally intensive signal processing. Cores integrated with subsystems (e.g. memory management units and floating point processors) that increase processing bandwidth and enable the design of highly-integrated systems are desired. Of particular interest are implementations that facilitate component-level connectivity and interoperability by low voltage differential signaling (LVDS) serial interfaces, and approaches that employ power-efficient voltage translation. Solutions adherent to standards that facilitate efficient development and test are desired. Selected proposers must provide or refer to an existing compatible microprocessor software development environment. Measured or projected performance metrics are indicated in Table 1.2.1.

Metric	Requirement	Goal
Sustained Processor Efficiency	≥ 200 MIPS/W	> 400 MIPS/W
Sustained Performance	scaleable from 20 MIPS to 200 MIPS at required processor efficiency metric	scaleable from DC to full performance at stated processor efficiency metric
Min. Operational Temperature Range	-55 °C ≤ T ≤125 °C	-
Total Ionizing Dose	≥ 100krad (Si)	-
Upset Rate	≤ 1E-10 errors/bit-day	-
Single Event Latchup Immunity	≥ 100 MeV-cm^2/mg	-

Table 1.2.1 - High Performance General Purpose Processor Metrics

1.2.2 High-Performance General Purpose 16-Bit and 32-Bit Configurable Platforms

This area solicits embedded configurable platforms capable of implementing computationally intensive signal processing in spaceflight instruments and systems. Among the applications are application-specific lossy data compression, embedded image processing, and controllers for robotic electromechanical subsystems. Components that integrate a processor core with end-user configurable functions and subsystems (e.g. onboard memory, embedded analog-to-digital and digital-to-analog converters, embedded field-programmable gate arrays, timers) that increase processing bandwidth and promote the design of highly-integrated systems are desired. Of particular interest are implementations that facilitate component-level connectivity and interoperability by LVDS serial interfaces, and approaches that employ power-efficient voltage translation. Solutions adherent to standards that facilitate efficient development and test are desired. Selected proposers must provide or refer to an existing compatible software development environment. Measured or projected performance metrics indicated in Table 1.2.2.

Metric	Requirement	Goal
Sustained Processor Efficiency	≥ 100 MIPS/W	> 200 MIPS/W
Sustained Performance	Scaleable from 10 MIPS to 100 MIPS at required processor efficiency metric	scaleable from DC to full performance at stated processor efficiency metric
Min. Operational Temperature Range	-55 °C ≤ T ≤125 °C	-
Total Ionizing Dose	≥ 100krad (Si)	-
Upset Rate	≤ 1E-10 errors/bit-day	-
Single Event Latchup Immunity	≥ 100 MeV-cm^2/mg	-

Table 1.2.2 - High Performance Configurable Platform Metrics

1.2.3 High-Speed Analog-To-Digital Converters

Analog-to-digital converters are required to digitize signal nodes on instrument and spacecraft systems. Architectures for proposed components must accommodate a variable sample rate and incorporate user-configurable parallel and LVDS serial interfaces. Measured or projected performance metrics are indicated in Table 1.2.3.

Metric	Requirement	Goal
Resolution (bits) (no missing codes)	14	16
Sampling Rate	≥ 1 MSPS	50 MSPS
Latency	≤ 2 μs	-
Integral Non-Linearity	≤ ± 2 LSB	≤ ± 1 LSB
Differential Non-Linearity	≤ ± 1 LSB	≤ ± 0.75 LSB
Input Voltage Range	0-2V, fully differential	-
Sample and Hold	Internal	-
Voltage Reference	User selected internal / external	-
Min. Operational Temperature Range	-55 °C ≤ T ≤125 °C	-
Power Dissipation	≤ 50 mW/MSPS	≤ 10 mW/MSPS
Total Ionizing Dose	≥ 100krad (Si)	-
Linear Energy Transfer	≥ 37 MeV-cm^2/mg	-
Single Event Latchup Immunity	≥ 100 MeV-cm^2/mg	-

Table 1.2.3 - High-Speed A/D Converter Metrics

1.2.4 Digital and Mixed-Signal Application Specific Integrated Circuit (ASIC) Design Capability

Performance requirements and resource constraints mandate certain high-performance algorithms and interfaces to be implemented with application-specific digital and mixed-signal circuits. This area seeks an electronic design automation environment, methodology or capability (e.g. design tools, techniques, libraries) that will enable and expedite the design, verification, synthesis and fabrication of custom and semi-custom radiation tolerant low-power digital and mixed-signal ASICs. Design implementation flows must facilitate reusability, low risk and low total-systems cost. Minimum radiation performance metrics for components derived from this capability are as follows:

Metric	Requirement
Min. Operational Temperature Range	-55 °C ≤ T ≤125 °C
Total Ionizing Dose	≥ 100krad (Si)
Linear Energy Transfer	≥ 37 MeV-cm^2/mg
Single Event Latchup Immunity	≥ 100 MeV-cm^2/mg

Table 1.2.4 – Digital and Mixed-Signal ASIC Design Capability Metrics

1.2.5 Low Power Architectures

This topic solicits innovative architectural solutions that integrate multiple device- and module level low-power components into a low-power system architecture. Low-power considerations must be addressed at the system level to achieve overall system-level power efficiency. This topic solicits both architectural concepts as well as power modeling and estimation tools that will enable the design of a complete low-power, and power efficient architecture.

1.3 Low Power and Radiation Effects Analysis and Verification

Proposers must discuss concepts, technologies, circuit design solutions and component fabrication processes, as applicable, in sufficient detail to prove minimum performance metrics are met or are achievable; projected performance data must be substantiated analytically or experimentally. Projected power efficiency of proposed devices must be substantiated at the component level and also in the context of how the component will be used in a typical system.

Components derived from this solicitation must meet the above-specified minimum radiation tolerance metrics with minimal degradation in static or dynamic performance or shift in operating points. Responses must include a discussion of component mitigation, hardening, and correction methods that will be used to achieve these objectives. Responses must also describe, as applicable, tests and methods that will be used to verify performance metrics.

2. Programmatic Considerations

2.1 Size and Duration of Awards

It is anticipated that $3.0M annually will be available to support Low Power Microelectronics selections, pending the approval of the NASA's Fiscal Year 2004 budget. Awards are expected to range from $100K to $500K per year. Proposals may specify periods of performance of up to three years.

Progress reports for funding the second or subsequent years of research, for previously approved multiple year awards, will be considered separately and should be sent directly to the LPμE Project Manager 60 days before their funding anniversary date. In addition, the participation of all selected investigators in the annual LPμE Project Review will be required.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Aerospace Technology (OAT) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening http://research.hq.nasa.gov/ and linking through "Helpful References," or by direct access at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2003-edition of the *Guidebook* is used for this solicitation). A table outlining a summary of instructions for the preparation and submission of proposals including reference points and page limits is provided in Appendix C.

- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal. Instructions for the electronic submission are provided in Appendix D.

- A quad chart in Microsoft PowerPoint format (template contained in Appendix B) will also be required. Include a printed copy in the proposal, and submit an electronic copy to http://141.156.25.46/msmt/

- Proposals involving NASA employees as either a PI or a Co-I must use Full Cost Accounting in the Budget Summary, including all Civil Service salaries with overhead.

Questions about this program element may be directed to the cognizant Program Officer:

Dr. Jesse A. Leitner
Project Manager, Revolutionary Spacecraft Systems
Code 571
NASA Goddard Space Flight Center
Greenbelt, MD 20771
Telephone: (301) 286-2630
Facsimile: (301) 286-1719
Email: Jesse.A.Leitner@nasa.gov

APPENDIX B

QUAD CHART TEMPLATE

The following is a template for the quad chart required for each proposal (to be generated in Microsoft PowerPoint format). It is to be included in the proposal immediately after the cover page material. An electronic copy should also be submitted to the web site at http://141.156.25.46/msmt/.

Proposal Title

Products

Insert sketch or image to illustrate system concept or technology product to be developed. Annotate image as necessary to explain what is shown.

Objectives

- Long-range performance objective or vision that the proposed task aims to achieve
- Expected benefits of proposed technology to future NASA missions
- Brief description of product at the end of first year
- Brief description of product at end of third year

Participants

- Principal investigator, affiliation, email, phone number
- Major Co-investigator, affiliations

Schedule and Funding

Milestones	Year 1	Year 2	Year 3
milestone #1	X		
milestone #2		X	
milestone #3			X
Required Funding	$K	$K	$K
Co-Funding (if applicable)			

APPENDIX C

SUMMARY OF PROPOSAL SUBMISSION GUIDELINES, SAMPLE SYS-EYFUS FORMS, AND CERTIFICATIONS

This table has been developed as a helpful guide for preparing the proposal. Please use the Guidebook for Proposers Responding to a NASA Research Announcement (NRA) at http://www.hq.nasa.gov/office/procurement/nraguidebook/ for clarification.

Proposal Content	**Page Guideline**	**Section and Appendix References**
1. Proposal Cover Page: the proposed PI and an institutional official who is authorized to certify institutional support and sponsorship of the investigation and of the management of the proposal must sign the proposal cover sheet. Also included on the cover page should be the name and information for the Co-I (s). (The electronic proposal submission process located at http://proposals.hq.nasa.gov/proposal.cfm/ generates this form).	1	Appendix C Use the SYS-EYFUS Cover Page
Indicate on the SYS-EYFUS cover page which of the program elements the proposal will address. Choose this in the Science Area section. Also, indicate which specific area(s) will be addressed. (Theme).		
Advanced Measurement and Detection Technology Development of detector arrays, laser sources, and in situ micro-instruments to support the Advanced Measurement and Detection (AMD) Project. **Areas:** - *Focal Plane Technologies for Remote Sensing, Active, and Astrophysics Instruments* - *Laser Materials and Systems for In Situ and Active Remote Sensing Applications* - *In Situ Sensor Systems for Astronaut Habitat Environmental Monitoring, Planetary Atmospheres, and Particle Measurement*		
Large Aperture Technology Development of technologies for large optical systems, antennas, and wavefront control to support the Large Space Systems (LSS) Project. **Areas:** - *Large Optical Systems* - *Large Radiometer and Radar Systems* - *Wavefront Sensing and Control*		
Low Power Microelectronics Technology Development of low power radiation tolerant microelectronics to support the Revolutionary Spacecraft Systems (RSS) Project. **Areas:** - *High-Performance General Purpose 32-Bit and 64-Bit Microprocessors* - *High-Performance General Purpose 16-Bit and 32-Bit Configurable Platforms* - *High-Speed Analog-To-Digital Converters* - *Digital and Mixed-Signal Application Specific Integrated Circuit (ASIC) Design Capability* - *Low Power Architectures*		
Proposal Abstract (200-300 words). Include a description of the		

Proposal Content	**Page Guideline**	**Section and Appendix References**
project's objectives, number of participants in the project, method of approach, and the measurable outcomes. A sample electronic Proposal Abstract page is included in this Appendix. **Proposed Cost**: The budget section of the electronic proposal cover page should include a budget breakdown for each year of the proposed work (3 years). The electronic form will provide a total summary for the entire period of the proposal. The length of the electronic proposal cover page (as generated via SYS-EYFUS) may vary depending upon the length of the proposal abstract/summary. However, the total cover-page packet, including the summary and budget figures, will count as only 1 page total. A sample cover page packet is included in this Appendix. **To print the Proposal Cover Page**, select "View" and then use the "Print" Button on your Internet browser menu. Make sure your printed copy includes the Abstract and the breakdown of Budget Categories. Submit this Proposal Cover Page with your proposal hard copy.		
2. Quad Chart: The quad chart is required for each proposal (to be generated in Microsoft PowerPoint format). It is to be included in the proposal immediately after the cover page material.	1	Appendix D for specific instructions.
3. Table of Contents	1	
4. Summary of Personnel and Work Efforts The item must provide a summary list, using a tabular format of the proposer's own choosing, of the names and intended work commitments (in units of a percentage of a nominal full time Work Year of 1840 hours) of the PI and of every Co-I in the proposed investigation for whom salary support is requested for each year of the proposed period of performance	1	
5. Scientific/Technical/Management Section See Guidebook For Proposers Responding to a NASA Research Announcement (NRA) page 2-5 for an elaboration. (http://www.hq.nasa.gov/office/procurement/nraguidebook/)	15	Evaluation Criteria
6. References and Citations All references and citations given in the Scientific /Technical/Management Section must be provided using easily understood, standard abbreviations for journals and complete names for books. It is highly preferred but not required that these references include the full title of the cited paper or report.	As Needed	
7. Facilities and Equipment This section should describe any facilities (including any owned by the U.S. Government) and/or test or experiment equipment valued over $5,000 that are critical for carrying out the proposed project, whether it is already available or would need to be purchased**.**	2	
8. PI and Co-I Curriculum Vitae	3(PI) 1 (each Co-I)	
9. Current and Pending Support Information must be provided for all ongoing and pending	As Needed	

Proposal Content	**Page Guideline**	**Section and Appendix References**
projects and proposals that involve the proposing PI. This information is also preferred but not required for any Co-I's who are proposed to perform a significant share (>10 percent) of the proposed work. Provide Information for the following: **Current Awards** (for any of the period that overlaps with the submitted proposal), and **Pending Awards** (including the proposal being submitted to NASA).		
10. Statement(s) of Commitment Every Co-Investigator and Collaborator identified as a participant in the proposal's Scientific/Technical/Management Section must submit a brief, signed statement of commitment that acknowledges his/her intended participation in the proposed effort. In the case of more than one Co-I or Collaborator, a single statement signed by all participants may be submitted.	As Needed	
11. Budget Narrative Include explanatory notes for each line item in the budget.	As Needed	
12. Special Notifications and Certifications	As Needed	
13. Reprints/Preprints Reprints from and/or preprints for peer-reviewed publications that are considered critical to the background of a proposal may be appended to a proposal. However, while there is no limit on the number of such items that may be appended, proposers should note that NASA's reviewers are instructed that there is no obligation to read them and that their judgment of the proposal's merits is to be based only on the proposal's contents and not on the perceived quality or quantity of any appended items.	As Needed	

SAMPLE PROPOSAL COVER PAGE

(Date : mmm dd, yyyy)

NRA 03-OAT-01

Name of Submitting Institution: **Congressional District:**

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in this Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications contained in this NRA namely,

(i) Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and

(ii) Certifications, Disclosures, And Assurances Regarding Lobbying and Debarment & Suspension]. Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001.

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

[1] ... PI Information

Name:		**Email:**	
Organization:			
City, State, Zip:		**Country:**	

PI Signature and Date:

Authorizing Official:		**Email:**	
Title:		**Phone:**	
Institution:			
Address:			

AO Signature and Date:

[2] ... Co-Investigator

Name:		**Email:**	
Organization:			
City, State, Zip:		**Country:**	

[3] ... Proposal Title (Short and/or Full)

Short Title:	
Full Title:	

[4] ... Science Areas (Can choose multiple science areas)

Advanced Measurement and Detection Technology (AMDT) Large Aperture Technology (LAT) Low Power Microelectronics Technology (LPMT)

[5] **... Theme** (Choose the Enterprise(s) to be involved)

Focal Plane Technologies for Remote Sensing, Active, and Astrophysics Instruments Laser Materials and Systems for In Situ and Active Remote Sensing Applications In Situ Sensor Systems for Astronaut Habitat Environmental Monitoring, Planetary Atmospheres, and Particle Measurement Large Optical Systems Large Radiometer and Radar Systems Wavefront Sensing and Control High-Performance General Purpose 32-Bit and 64-Bit Microprocessors High-Performance General Purpose 16-Bit and 32-Bit Configurable Platforms High-Speed Analog-To-Digital Converters Digital and Mixed-Signal Application Specific Integrated Circuit (ASIC) Design Capability Low Power Architectures

[6] **... Summary**

200-300 word abstract

[7] ... Budget

Type	**Year 1**	**Year 2**	**Year 3**	**Total**
Direct Labor				
Other Direct Costs - Subcontracts				
- Consultants				
- Equipment				
- Supplies				
- Travel				
- Other				
Indirect Costs				
Other Applicable Costs				
Subtotal - Estimated Costs:				
Less: Proposed Cost Sharing - Cost Sharing:				
Budget Total				

CERTIFICATIONS, DISCLOSURES, AND ASSURANCES PURSUANT TO LOBBYING, DEBARMENT & SUSPENSION, NONDISCRIMINATION AND DRUG-FREE WORKPLACE

A. LOBBYING

As required by Section 1352, Title 30 of the US Code, and implemented at 14 CFR Part 1271, as defined at 14 CFR Subparts 1271.110 and 1260.117, with each submission that initiates Agency consideration of such applicant for award of a Federal contract, grant, or cooperative agreement exceeding $100,000, the applicant must certify that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, Disclosure Form to Report Lobbying, in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

B. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

As required by Executive Order 12549, and implemented at 14 CFR 1260.510, for prospective participants in primary covered transactions, as defined at 14 CFR Subparts 1265.510 and 1260.117

1. The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

2. Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

C. NONDISCRIMINATION IN FEDERALLY ASSISTED PROGRAMS

The institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called Applicant, HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1972 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250)(hereinafter called NASA) issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from NASA; and HEREBY GIVES ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement. If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, and transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by NASA. THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The applicant recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620). This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about
  (1) the dangers of drug abuse in the workplace;
  (2) the grantee's policy of maintaining a drug-free workplace;
  (3) any available drug counseling, rehabilitation, and employee assistance programs, and
  (4) the penalties that may be imposed upon employees for drug abuse violations in the work place;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will (1) Abide by the terms of the statement; and (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;
(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted -

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted;

  (1) Taking appropriate personnel action against such an employee, up to and including termination; or
  (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

APPENDIX D

NOTICE OF INTENT AND PROPOSAL SUBMISSION INSTRUCTIONS

Online Submission Instructions

Notice of Intent and Proposal Cover Pages are to be submitted electronically by entering the requested information through the SYS-EYFUS Web site located at: http://proposals.hq.nasa.gov/proposal.cfm .

SYS-EYFUS is an electronic system (SYS -) used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, contracts, etc.). SYS-EYFUS also supports the funding and administration of awards pursuant to selection of these research opportunities.

User Identifications (User ID)

User ID and passwords are required by NASA security policies in order to access the SYS-EYFUS Web site. Prospective Principal Investigators (PIs) can check if they have a SYS-EYFUS User ID and Password by going to http://proposals.hq.nasa.gov/proposal.cfm and performing the following steps:

- Click the hyperlink for NEW USER; this will take the user to the personal information Search Page.
- Enter the user's first and last name. SYS-EYFUS will search for matching record information in the SYS-EYFUS database.
- If matches are found, select the "correct" record from those displayed and then click on CONTINUE.
- If no exact match is found, select NONE OF THE ABOVE click on CONTINUE. Then complete the NEW USER form. Follow the on-line instructions for updating and/or entering new data. In addition to adding general contact information, areas of interest and expertise are required.
- If no match is found, select ADD RECORD. Follow the on-line instructions for updating and/or entering new data. In addition to adding general contact information, areas of interest and expertise are required.

A User ID and password will be emailed to you within minutes.

With the user ID and password, login to the SYS-EYFUS web site and follow the instructions for NEW NOTICE OF INTENT.

Specific Notice of Intent and Proposal Cover Pages SYS-EYFUS Instructions

- Click on link http://proposals.hq.nasa.gov/proposal.cfm
- The system will bring you to the "Welcome to Proposal Online Site" page.
- Clink on the Login link on the left sidebar.
- Enter your login id and password and click on the Continue button.
- The system will bring you to the "SYS-EYFUS Options Page".

- Click on the New Notice of Intent button to submit your Notice of Intent.
- The system will bring you to the "Division Specific Opportunities" page.
- In the dialog box, scroll down to "AeroSpace Technology" and click the Continue button.
- At the List of Existing Opportunities, select the MSMT-2004 Mission and Science Measurement Technology - 2004 opportunity in the window and click the Continue button.
- Begin entering your Notice of Intent information.

The Proposal Cover Pages should contain the following information:

- Names, addresses, telephone numbers, FAX number, electronic mail addresses, and affiliations of the Principal Investigator and all Co-Investigators,
- The name of the proposing organization(s),
- A long and short descriptive title for the proposed effort (the long title is to be entered under the "General Information" tab while the short title will be entered under the "Other" tab),
- The science area and which specific area (theme) that will be addressed by the proposal,
- A brief (200-300) description of the research to be conducted, and
- A total cost estimate by year.

Quad Chart Upload

- Access URL: http://141.156.25.46/msmt/
- Enter your unique SYS-EYFUS Identification Number.
- Click on Browse button to retrieve PowerPoint Quad Chart.
- Double click on PowerPoint Chart to attach and bring link into dialog window.
- Click on Upload Button to upload chart.
- You will receive confirmation of successful upload.
- Hard copies are to be mailed in with copies of your proposal.